the university for Ulster, began earlier than that happy part of my life. My father, born in County Down, was for four years (1810 to 1814) a student of the University of Glasgow, and in his Irish home, first as professor of mathematics in the newly-founded Royal Belfast Academical Institution, his children were taught to venerate the University of Glasgow. One of my earliest memories of those old Belfast days is of 1829, when the joyful intelligence came that the Senate of the University of Glasgow had conferred the honorary degree of Doctor of Laws on my father. Two years later came the announcement that the faculty of Glasgow College had elected him to the professorship of mathematics.

In 1834, two years after my father was promoted from Belfast to the Glasgow professorship of mathematics, I became a matriculated member of the University of Glasgow. To this day I look back to Prof. William Ramsay's lectures on Roman antiquities and readings of Juvenal and Plautus as more interesting than many a good stage play that I have seen in the theatre. Happy it is for our university, and happy for myself, that his name, and a kindred spirit, are with us still in my old friend and colleague, our senior professor, George Ramsay. Greek, under Sir Daniel Sandford and Lushington, logic under Robert Buchanan, moral philosophy under William Fleming, natural philosophy and astronomy under John Pringle Nichol, chemistry under Thomas Thomson (a very advanced teacher and investigator), natural history (zoology and geology) under William Couper, were, as I can testify by my own experience, all made interesting and valuable to the students of Glasgow University in the 'thirties and 'forties of the nineteenth century. Sandford, in teaching his junior class the Greek alphabet and a few characteristic Greek words, and the Scottish pronunciation of Greek, gave ideas, and something touching on philology, to very young students, which remains on their minds after the heavier grammar and syntax which followed have vanished from their knowledge. Logic was delightfully unlike the Collegium Logicum described by Goethe to the young German student through the lips of Mephistopheles. Even the dry bones of predicate and syllogism were made by Prof. Buchanan very lively for six weeks among the students of logic and rhetoric in Glasgow College sixty-seven years ago; and the delicious scholastic gibberish of "Barbara, Celarent" remains with them an amusing recollection. A happy and instructive illustration of the inductive logic was taken from Wells's "Theory of Dew," then twenty years old. My predecessor in the natural philosophy chair, Dr. Meikleham, taught his students reverence for the great French mathematicians, Legendre, Lagrange, Laplace. His immediate successor in the teaching of the natural philosophy class, Dr. Nichol, added Fresnel and Fourier to this list of scientific nobles; and by his own inspiring enthusiasm for the great French school of mathematical physics, continually manifested in his experimental and theoretical teaching of the wave theory of light and of practical astronomy, he largely promoted scientific study and thorough appreciation of science in the University of Glasgow. In this hall you see side by side two memorial windows presented to the university to mark permanently its admiration of three men of genius, John Caird, John Pringle Nichol, and his son, John Nichol, who lived in it, and worked for it and for the world, in the two departments of activity for which universities exist, the humanities and science. As far back as 1818 to 1830 Thomas Thomson, the first professor of chemistry in the University of Glasgow, began the systematic teaching of practical chemistry to students, and by aid of the faculty of Glasgow College, which gave the site and the money for the building, realised a well equipped laboratory, which preceded, I believe, by some years Liebig's famous laboratory of Giessen, and was, I believe, the first of all the laboratories in the world for chemical research and the practical instruction of university students in chemistry. That was at a time when an imperfectly informed public used to regard the University of Glasgow as a stagnant survival of mediævalism and to call its professors the Monks of the Molendinar!

The university of Adam Smith, James Watt, and Thomas Reid was never stagnant. For two centuries and a quarter it has been very progressive. Nearly two centuries ago it had a laboratory of human anatomy. Seventy-five years ago it had the first chemical students' laboratory. Sixty-five years ago it had the first professorship of engineering of the British Empire. Fifty years ago it had the first physical students' laboratory—a deserted wine cellar of an old professorial house, enlarged a few years later by the annexation of a deserted examination room. Thirty-four years ago, when it migrated from its four hundred years old site off the High Street of Glasgow to this brighter and airier hill-top, it acquired laboratories of physiology and zoology, too small and too meagrely equipped. And now every university in the world has, or desires to have, laboratories of human anatomy, of chemistry, of physics, of physiology, of zoology. Within the last thirty years laboratories of engineering, of botany, and of public health have been added to some of the universities of the British Empire, with highly beneficent results for our country and the world. All these the University of Glasgow now has. During the last fifty years our university has grown in material greatness and in working power to an extent that its most ardent well-wishers in the first half of the nineteenth century could scarcely have imagined possible. Two successive legislative commissions (1858 and 1889) have re-formed its constitution and broadened its foundations, and added to its financial resources, and admitted women to its membership, with all the privileges of students and graduates. Splendidly liberal subscriptions by the people of Glasgow and by a world-wide public outside, backed by powerful aid from the National Treasury, enabled the university, on leaving its ancient site, to enter into the grand group of buildings on Gilmorehill, in which it has happily lived ever since. A few years later the generous gift of 45,000*l.* by the late Marquis of Bute built the hall called after his name, in which we are now met. At the same time the adjoining Randolph Hall and staircase were built by a portion of the legacy left to the university by the late Mr. Randolph. The Queen Margaret College and grounds were presented to the university by Mrs. Elder, who also added largely to the endowment of the engineering professorship, and founded the professorship of naval architecture. Other generous donors have given an engineering laboratory with lecture-rooms, and botanical buildings, and great and much needed extensions in the anatomical department. The Carnegie Trust and the principal's university equipment scheme are at present providing two new buildings; one of these is for extensions in the medical school. The other, in which I naturally take the most personal interest, is for the natural philosophy department, including lecture-rooms and a physical laboratory, all designed and at present being realised under the able direction of my successor in the natural philosophy chair, Prof. Andrew Gray.

In the province of the humanities the working power of the university for instruction and research has been largely augmented during the last fifty years by the foundation of new professorships, conveyancing, English language and literature, Biblical criticism, clinical surgery, clinical medicine, history (in my opinion the most important of all in the literary department), pathology, political economy. In mathematics and in the science of dead matter, professorships of naval architecture and geology; lectureships of electricity, of physics, and of physical chemistry; and demonstratorships and official assistantships in all departments have most usefully extended the range of study, and largely strengthened the working corps for research and instruction. I venture to congratulate the city of Glasgow on having for her god-daughter a university so splendidly equipped and so admirably provided with workers.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE report of the council of the Royal Society was presented at the anniversary meeting held yesterday, November 30, and the president, Sir William Huggins, K.C.B., F.R.S., delivered the annual address.

The council refers to the second general assembly of the International Association of Academies last Whitsuntide as one of the chief events of the year. At the

close of the meeting, Vienna was chosen by a unanimous vote as the place of meeting of the next general assembly. A complete protocol of the proceedings of the assembly has been drawn up, and will be issued before the end of this year. Other matters referred to in the report are the African geodetic arc, the international congress of aëronautics held at St. Petersburg in August, the international laboratory of physiology on Monte Rosa, the Royal Society "Catalogue of Scientific Papers," the "International Catalogue of Scientific Literature," the Government grant for scientific investigations, and the expenses of special Government inquiries.

The Royal Society is frequently requested by various departments of the Government to advise upon, or in some cases to undertake the supervision and control of, and in others the entire responsibility for, scientific investigations of national importance, but no provision has been made by Government to meet expenses to which the Society has been put in acceding to these requests. As the result of pointing out this unsatisfactory position, H.M. Treasury has approved of an alteration in the regulations for administering the Government grant of 4000*l.* for scientific purposes which will permit a sum to be set aside out of the reserve fund of the grant for printing and office expenditure incurred "in undertaking, controlling, supervising or advising upon matters which the President and Council may, at the request of the Government, undertake, control, supervise or advise upon." That is to say, the Royal Society is graciously permitted by the Treasury to use a part of the annual Government grant for scientific investigations to meet expenses incurred in answering Government inquiries.

Mention is also made in the report of the radium research grant of the Goldsmiths' Company, the Treasury inquiry into the Meteorological Office, and the letter on scientific education sent by the council to all British universities last January. The following extracts from other parts of the report of the council are of interest:—

Sleeping Sickness.

The investigation of this disease in Uganda was continued after Colonel Bruce's return to England by Dr. Nabarro and Captain Greig, of the Indian Medical Service. A further report (No. 4) by Colonel Bruce has been published, and its general conclusions, briefly stated in the last report of the council—namely, that the sleeping sickness is caused by the entrance into the blood and thence into the cerebro-spinal fluid of a species of Trypanosoma (*T. gambiense*), and that these trypanosomes are transmitted from the sick to the healthy by a species of tsetse fly (*Glossina palpalis*)—have been confirmed by subsequent observations. The efforts of the observers are now being directed to the attempt to discover a means of eliminating the trypanosomes from the blood and tissues of the infected in the early stages, and before severe damage has been done to the nervous centres. In the meantime the Royal Society Committee has advised the Government to adopt such preventive measures as are found practicable for protecting a non-infected area where the carrier fly is found from the incursion of emigrants from the infected areas.

Antarctic Expedition and Investigation.

The Antarctic ship *Discovery*, accompanied by the relief ships *Morning* and *Terra Nova*, returned safely in March last to Lyttelton, and a "Summary of Proceedings was forwarded thence by Captain Scott by post to the presidents of the Royal and Royal Geographical Societies. The *Discovery* arrived in England at the beginning of September, when a joint letter of welcome from the president and the president of the Royal Geographical Society was dispatched to Captain Scott.

The natural history specimens and notes and drawings have been sent to the British Museum (Natural History Department), to be preserved there as part of the national collection, the trustees of the museum having agreed to organise and undertake the publication of these results of the expedition, under the editorship of the director of the museum.

The laborious duty of arranging for the reduction and publication of the magnetic and meteorological observations made by the expedition has been undertaken by the Royal Society. Two special expert committees have been appointed, and are already dealing with these two classes of material.

As regards the magnetic observations, the Hydrographic Department of the Admiralty has undertaken the reduction of about one-third of the material, and the remaining two-thirds, consisting of the slow-run magnetograms, remain to be dealt with. The committee for magnetism have accordingly arranged that these observations shall be reduced, under the superintendence of Dr. Chree, their secretary, in the observatory department of the National Physical Laboratory; and the Royal Society has undertaken responsibility for the cost of these reductions, to the extent of 400*l.*, by an advance from the donation fund, in the full hope that this expenditure will be refunded out of the proceeds of the sale of the *Discovery*.

Committees have been arranged for dealing with other observations. The reduction of the meteorological observations has been undertaken by the Meteorological Council with the aid of a sum of 500*l.* guaranteed by the Royal Geographical Society in anticipation of the sale of the *Discovery*. It is hoped that the publication of these results will be undertaken by H.M. Stationery Office.

The committees are working as far as possible in concert with the authorities engaged in the reduction of the observations of the German and Scottish Antarctic Expeditions, which in part covered the same period of time.

It is proposed that the special scientific results of the expedition shall be published in a uniform series of volumes similar to the published records of the *Challenger* Expedition.

Mediterranean Fever.

In February last a letter was received from the Colonial Office asking whether the Royal Society would be willing to appoint an advisory board in this country for the purpose of supervising investigations into Mediterranean fever, to be carried out by a commission representing the Navy, the Army, and the Civil Government of Malta.

The matter was referred to the tropical diseases committee of the society, which had superintended the investigations into malaria and sleeping sickness, and upon their advice the council decided to accede to the request of the Colonial Office, provided that the appointment of investigators rested with the Royal Society, and that all expenses in connection with the investigation were borne by the Government. These conditions were accepted by the Government with a modification, which the council acceded to at the particular request of H.M. Treasury, viz. that the Royal Society should participate by defraying (out of the Government Grant Reserve Fund) the cost of scientific equipment to an amount not exceeding 200*l.* The advisory board was constituted as a subcommittee of the tropical diseases committee, with Colonel Bruce, F.R.S., as chairman. Members of the commission of investigation were nominated, with the approval of this committee, by the Navy, the Army, and the Civil Government of Malta, and Colonel Bruce himself went out to Malta on behalf of the committee to start the inquiry, which is now in active progress.

National Physical Laboratory.

The National Physical Laboratory has continued its work with success during the year, the last of the five for which the original annual grant of 4000*l.* was made by the Treasury.

This fact has been prominently before the committee at its various meetings. In reply to an inquiry by the chairman, a letter was received from Sir E. W. Hamilton to the effect that while there was no idea of stopping the grant, the question before H.M. Treasury was whether there should be an increase in its amount, and suggesting that the committee should formulate "constructive proposals" with detailed estimates of the expenditure, both capital and recurring, required to put the laboratory on a satisfactory footing. Accordingly this was done, and a memorandum on the future organisation and expenditure of the labor-

atory, which was drawn up by the executive committee on February 19, was sent to the Treasury by the president and council, who strongly supported the proposals of the committee.

The main recommendations of the memorandum were (1) that a sum of nearly 30,000*l.* was required for capital expenditure, and (2) that the annual grant should be raised in the course of four years to 10,000*l.*; while, with a view to supporting these proposals, a request was made for an official inquiry into the work and organisation of the laboratory.

To this request the Financial Secretary of the Treasury replied, stating that the question of the increase must stand over until the estimates for 1905–6 were under consideration, and suggesting that meanwhile the executive committee should consider which of the new works were of the most pressing importance, and make application accordingly.

In answer, a further memorandum was prepared, pointing out that the question at issue was whether the laboratory is to be allowed to remain undeveloped in its present condition, with its limited powers and opportunities, or whether it is to be adequately developed, and ultimately placed on a footing similar to that of the corresponding institutions in other countries, and asking that the First Lord of the Treasury would receive a deputation to support the request already made, "That an inquiry might be instituted into the work and organisation of the National Physical Laboratory with a view to laying down the lines that ought to be followed in its future development."

In consequence of this request, a conference took place early in August at the House of Commons between the Prime Minister, the Chancellor of the Exchequer, and the President of the Board of Trade on the one hand, and Lord Rayleigh, Sir F. Hopwood, the treasurer and senior secretary of the Royal Society, with the director, representing the laboratory, at which the matter was discussed.

The donations and subscriptions promised to the laboratory, in most cases for five years, have increased, and now reach a total of about 2000*l.*

While the report is one of progress, the committee of the laboratory feel that with adequate financial support they might do much more. It is not yet sufficiently recognised how substantial is the assistance the laboratory can render to commerce and manufactures. The grant made by the Government is treated by them as one in aid of science itself, although it is applied under the highest scientific direction to facilitate the applications of science to manufacture. This distinction is an important one, which needs to be emphasised; when it is fully grasped the progress of the laboratory, as an aid to national industry, will be much more rapid.

In his anniversary address the president referred at first to the scientific careers of the thirteen fellows of the Society lost by death since the previous anniversary. He then gave a sketch of the work the society has done and is doing for the nation, and showed how the generous intentions of the founder, Charles II., were never fulfilled. From this survey of the history of the society, we have taken the following extracts, with the descriptions of the scientific work of this year's medallists:—

During the last few years a very large amount, increasing each year, of work outside the reading, discussion, and printing of papers, of a more or less public character, has been thrown upon the Royal Society—so large indeed as at present to tax the society's powers to the utmost. A not inconsiderable part of this work has come from the initiation by the society itself of new undertakings, but mainly it has consisted of assistance freely given, at their request, to different departments of the Government on questions which require expert scientific knowledge, and which involve no small amount of labour on the part of the officers and staff, and much free sacrifice of time and energy from fellows, in most cases living at a distance.

There is little doubt that this largely-increased amount of public work has arisen, in part naturally from the greater scientific activity of the present day, but also, and to a greater extent, from the fuller recognition by the Government and the public of the need for scientific advice and direction in connection with many matters of national concern.

It may not be inopportune, therefore, for me to say a few words on the advisory relation in which the society has come to stand to the Government, and to review very briefly the great work which the society has done, and is doing, for the nation.

Among academies and learned societies the position of the Royal Society is, in some respects, an exceptional one. In the British dominions it holds a unique position, not only as the earliest chartered scientific society, but in its own right, on account of the number of eminent men included in its fellowship, and the close connection in which it stands, though remaining a private institution, with the Government. The Royal Society is a private learned body, consisting of a voluntary and independent association of students of science united for the promotion of natural knowledge at their own cost.

The Royal Society, while remaining a purely private institution for the promotion of natural knowledge, has been regarded by the Government as the acknowledged national scientific body, the advice of which is of the highest authority on all scientific questions, and the more to be trusted on account of the society's financial independence; a body, which, through its intimate relations with the learned societies of the Colonies, has now become the centre of British science. The society's historical position and the scientific eminence of its fellows have made it naturally the body which the scientific authorities of foreign countries regard as representing the science of the Empire, and with which they are anxious to consult and to cooperate, from time to time, on scientific questions of international importance.

On their part, the fellows of the Royal Society, remembering that the promotion of natural knowledge is the great object for which it was founded and still exists, and that all undertakings in the home and in the State, since they are concerned with nature, can be wisely directed and carried on with the highest efficiency only as they are based upon a knowledge of nature, have always recognised the fundamental importance of the society's work to national as well as to individual success and prosperity, and their own responsibility as the depositories of such knowledge. They have always been willing, even at great personal cost, ungrudgingly to afford any assistance in their power to the Government on all questions referred to them which depend upon technical knowledge, or which require the employment of scientific methods. In particular the society has naturally always been eager to help forward, and even to initiate, such national undertakings as voyages of observation or of discovery of any kind, or for the investigation of the incidence of disease, which have for their express object the increase of natural knowledge.

At the same time, as the society is dependent upon the voluntary help of its fellows, whose time is fully occupied with their own work, the society may reasonably expect the Government not to ask for assistance on any matters of mere administration that could be otherwise efficiently provided for. The hope may be expressed that in the near future, with increased official provision in connection with the recognition of science, the position of the society to the Government may not extend beyond that of a purely advisory body, so that the heavy responsibilities now resting upon it, in respect of the carrying out of many public undertakings on which its advice has been asked, may no longer press unduly, as they certainly do at present, upon the time and energy of the officers and members of committees. The society regards this outside work, important as it is, as extraneous, and therefore as subordinate, and would not be justified in permitting such work to interfere with the strict prosecution of pure natural science as the primary purpose of the society's existence, upon which, indeed, the society's importance as an advisory body ultimately depends.

The society has accepted heavy responsibilities at the instance of the Government in respect of the control of scientific observations and research in our vast Indian Empire. In 1899, the India Office inquired whether the Royal Society would be willing to meet the wishes of the Indian Government by exercising a general control over the scientific researches which it might be thought desirable to

institute in that country. A standing committee was appointed in consequence by the council for the purpose of giving advice on matters connected with scientific inquiry, probably mainly biological, in India, which should be supplementary to the standing observatories committee which was already established at the request of the Government as an advisory body on astronomical, solar, magnetic, and meteorological observations in that part of the Empire.

An investigation, onerous indeed, but of the highest scientific interest and of very great practical importance, has been carried on by a series of committees successively appointed at the request of the Government for the consideration of some of the strangely mysterious and deadly diseases of tropical countries. In 1896 a committee was appointed at the request of the Colonial Secretary to investigate the subject of the tsetse-fly disease in South Africa. Two years later Mr. Chamberlain, Secretary of State for the Colonies, requested the society to appoint a committee to make a thorough investigation into the origin, the transmission, and the possible preventives and remedies of tropical diseases, and especially of the malarial and "blackwater" fevers prevalent in Africa, promising assistance, both on the part of the Colonial Office and of the Colonies concerned. A committee was appointed, and, under its auspices, skilled investigators were sent out to Africa and to India. In the case of the third committee the society itself took the initiative. An outbreak in Uganda of the disease, appalling in its inexorable deadliness, known as "sleeping sickness" having been brought to the knowledge of the society, a deputation waited upon Lord Lansdowne at the Foreign Office, asking him to consider favourably the dispatch of a small commission to Uganda to investigate the disease. He gave his approval, and a commission of three experts, appointed on the recommendation of the committee, was sent out to Uganda, 600*l.* being voted out of the Government grant towards the expenses of the commission.

The investigations in tropical diseases, promoted and directed by these committees, have largely increased our knowledge of the true nature of these diseases, and, what is of the highest practical importance, they have shown that their propagation depends upon conditions which it is in the power of man so far to modify, or guard against, as to afford a reasonable expectation that it may be possible for Europeans to live and carry on their work in parts of the earth where hitherto the sacrifice of health, and even of life, has been fearfully great. A general summary of the work already done on malaria, especially in regard to its prevention, and also on the nature of "blackwater" fever, has been published in a Parliamentary paper, which records Mr. Chamberlain's acknowledgment to the Royal Society for its cooperation in the work undertaken by the Colonial Office. The reports on sleeping sickness up to this time form four whole numbers of the *Proceedings*, giving evidence in support of the view that this deadly disease is caused by the entrance into the blood, and thence into the cerebro-spinal fluid, of a species of Trypanosoma, and that these organisms are transmitted from the sick to the healthy by a kind of tsetse fly, and by it alone; sleeping sickness is, in short, a human tsetse-fly disease.

In 1897, the council was requested to assist the Board of Trade in drawing up schedules for the establishment of the relations between the metric and the imperial units of weights and measures. A committee was appointed, which, after devoting much time and attention to the matter, drew up schedules which were accepted by the Board of Trade and incorporated in the Orders of Council.

Soon after the reports were received of the appalling volcanic eruptions and the loss of life which took place in the West Indies in 1902, the council received a letter from Mr. Chamberlain to ask if the society would be willing to undertake an investigation of the phenomena connected with the eruptions. The council, considering that such an investigation fell well within the scope of the objects of the society, organised a small commission of two experts, who left England for the scene of the eruption eleven days only after the receipt of Mr. Chamberlain's letter, the expenses being met by a grant of 300*l.* from the Government Grant Committee. Six weeks were spent in the islands, including Martinique, by the commission, which was successful in securing results of great scientific interest. A preliminary report was published at the time, and a full report has since appeared in the *Transactions*.

Time forbids me to do more than mention the successive expeditions sent out by the society, conjointly with the Royal Astronomical Society, for the observation of total solar eclipses; and the onerous work thrown upon the society for several years in connection with the National Antarctic Expedition, undertaken jointly with the Royal Geographical Society, which has this year returned home crowned with success; but the society's labours are not at an end, for the prolonged and responsible task of the discussion and publication of the scientific results of the expedition is still before them.

To the Royal Society is entrusted the responsible task of administrating the annual Government grant of 4000*l.* for the purpose of scientific research, and a grant of 1000*l.* in aid of the publication of scientific papers.

In addition to these permanent responsibilities, which are always with the society, its advice and aid are sought from time to time both by the Government and by scientific institutions at home and abroad, in favour of independent objects of a more or less temporary character, of which, as examples, may be taken the recent action of the society for the purpose of obtaining Government aid for the continuation through Egypt of the African arc of meridian, and for the intervention of the Government to assist in securing the fulfilment of the part undertaken by Great Britain in the International Astrographic Catalogue and Chart.

Upon the present fellows falls the glorious inheritance of unbounded free labour ungrudgingly given during two centuries and a half for the public service, as well as of the strenuous prosecution at the same time of the primary object of the society, as set forth in the words of the Charter: "the promotion of Natural Knowledge." The successive generations of fellows have unsparingly contributed of their time to the introduction and promotion, whenever the opportunity was afforded them, of scientific knowledge and methods into the management of public concerns by departments of the Government. The financial independence of the Royal Society, neither receiving, nor wishing to accept, State aid for its own private purposes, has enabled the society to give advice and assistance which, both with the Government and with Parliament, have the weight and finality of a wholly disinterested opinion. I may quote here the words of a recent letter from H.M. Treasury:—"Their Lordships have deemed themselves in the past very fortunate in being able to rely, in dealing with scientific questions, upon the aid of the Royal Society, which commands not only the confidence of the scientific world, but also of Parliament."

In the past the Royal Society has been not infrequently greatly hampered in giving its advice by the knowledge that the funds absolutely needed for the carrying out of the matters in question in accordance with our present scientific knowledge would not be forthcoming. Though I am now speaking on my own responsibility, I am sure that the society is with me, if I say that the expenditure by the Government on scientific research and scientific institutions, on which its commercial and industrial prosperity so largely depend, is wholly inadequate in view of the present state of international competition. I throw no blame on the individual members of the present or former Governments; they are necessarily the representatives of public opinion, and cannot go beyond it. The cause is deeper, it lies in the absence in the leaders of public opinion, and indeed throughout the more influential classes of society, of a sufficiently intelligent appreciation of the supreme importance of scientific knowledge and scientific methods in all industrial enterprises, and indeed in all national undertakings. The evidence of this grave state of the public mind is strikingly shown by the very small response that follows any appeal that is made for scientific objects in this country, in contrast with the large donations and liberal endowments from private benefaction for scientific purposes and scientific institutions which are always at once forthcoming in the United States. In my opinion, the scientific deadness of the nation is mainly due to the too exclusively mediæval and classical methods of our higher public schools, and can only be slowly removed by making in future the teaching of science, not from text-books for passing an examination, but, as far as may be possible, from the study

of the phenomena of nature by direct observation and experiment, an integrai and essential part of all education in this country.

I proceed to the award of the medals.

Copley Medal.

The Copley Medal is awarded to Sir William Crookes, F.R.S., for his experimental researches in chemistry and physics, extending over more than fifty years. Ever since his discovery of the element thallium in the early days of spectrum analysis, he has been in the front rank as regards the refined application of that weapon of research in chemical investigation. Later, the discrepancies which he found in an attempt to improve weighings, by conducting the operation in high vacua, were tracked out by him to a repulsion arising from radiation, which was ultimately ascribed by theory to the action of the residual gas. This phenomenon, illustrated by the radiometer, opened up a new and fascinating chapter in the dynamical theory of rarefied gases, which the genius of Maxwell, O. Reynolds, and others, has left still incomplete. The improvements in vacua embodied in the Crookes tube led him to a detailed and brilliant experimental analysis of the phenomena of the electric discharge across exhausted spaces; in this, backed by the authority of Stokes, he adduced long ago powerful cumulative evidence that the now familiar kathode rays, previously described by C. F. Varley, must consist of projected streams of some kind of material substance. His simple but minutely careful experiments on the progress of the ultimate falling off in the viscosity of rarefied gases, from the predicted constant value of Maxwell, at very high exhaustions, gave, in Stokes's hands, an exact account of the trend of this theoretically interesting phenomenon, which had already been approached in the investigations of Kundt and Warburg, using Maxwell's original method of vibrating discs.

These examples, not to mention recent work with radium, convey an idea of the acute observation, experimental skill, and persistent effort, which have enabled Sir William Crookes to enrich physical science in many departments.

Rumford Medal.

The Rumford Medal is awarded to Prof. Ernest Rutherford, F.R.S., on account of his researches on the properties of radio-active matter, in particular for his capital discovery of the active gaseous emanations emitted by such matter, and his detailed investigation of their transformations. The idea of radiations producing ionisation, of the type originally discovered by Röntgen, and the idea of electrified particles, like the kathode rays of vacuum tubes, projected from radio-active bodies, had gradually become familiar through the work of a succession of recent investigators, when Rutherford's announcement of a very active substance, diffusing like a gas with a definite atomic mass, emitted by compound of thorium, opened up yet another avenue of research with reference to these remarkable bodies. The precise interpretation of the new phenomena, so promptly perceived by Rutherford, was quickly verified, for radium and other substances, by various observers, and is now universally accepted. The modes of degradation, and the enormous concomitant radio-activity, of these emanations, have been investigated mainly by Rutherford himself, with results embodied in his treatise on radio-activity and his recent Bakerian lecture on the same subject. It perhaps still remains a task for the future to verify or revise the details of these remarkable transformations of material substances, resulting apparently in the appearance of chemical elements not before present; but, however that may issue, by the detection and description of radio-active emanations and their transformations, Prof. Rutherford has added an unexpected domain of transcendent theoretical interest to physical science.

Royal Medal.

A Royal Medal is awarded to Prof. W. Burnside, F.R.S., on the ground of the number, originality, and importance of his contributions to mathematical science. The section of our "Catalogue of Scientific Papers" for the period 1883–1900 enumerates fifty-three papers by Prof. Burnside, the first dated 1885, and the "International Catalogue of Scientific Literature" thirteen more. His mathematical work has consisted largely of papers on the theory of groups, to which he has made most valuable additions. In 1897 he published a volume "On the Theory of Groups of Finite Order," which is a standard authority on that subject. Two recent papers on the same theory, published in 1903, may be specially mentioned. In one of these he succeeded in establishing by direct methods, distinguished by great conciseness of treatment, the important subsidiary theory of group-characteristics, which had been originally arrived at by very indirect and lengthy processes. In the other he proved quite shortly the important result that all groups of which the order is the product of powers of two primes are soluble.

Besides the treatise and papers relating to group theory, Prof. Burnside has published work on various branches of pure and applied mathematics. His work on automorphic functions dealt with an important and difficult special case which was not included in the theory of these functions as previously worked out. The paper on Green's function for a system of non-intersecting spheres was perhaps the first work by any writer in which the notions of automorphic functions and of the theory of groups were applied to a physical problem. He has also made important contributions to the theory of functions, non-Euclidean geometry, and the theory of waves on liquids. His work is distinguished by great acuteness and power, as well as by unusual elegance and most admirable brevity.

Royal Medal.

The other Royal Medal is awarded to Colonel David Bruce, F.R.S., who, since 1884, has been engaged in prosecuting to a successful issue researches into the causation of a number of important diseases affecting man and animals. When he went to Malta in 1884 the exact nature of the widely prevalent "Malta," "Rock," or "Mediterranean" fever was entirely unknown. After some years' work at the etiology of this disease, he discovered in 1887 the organism causing it, and succeeded in cultivating the *Micrococcus melitensis* outside the body. This discovery has been confirmed by many other workers, and is one of great importance from all points of view, and perhaps more especially as, thanks to it, Malta fever can now be separated from other diseases, *e.g.* typhoid, remittent, and malarious fevers, with which it had hitherto been confounded.

During the next few years he was engaged in researches of value on cholera, and on methods of immunisation against this disease. He also carried out some work on the leucocytes in the blood, published in the *Proceedings* of the Royal Society, 1894.

In 1894 he was requested by the Governor of Natal to investigate the supposed distinct diseases of "nagana" and the tsetse-fly disease. In the short time of two months he made the most important discovery that these two diseases were one and the same, and dependent upon the presence of a protozoan organism in the blood, known as a trypanosome. Some six months later Bruce was enabled to return to Zululand, and remained there two years, studying the disease and making the discovery that the tsetse fly acted as the carrier of the organism which caused it. He was thus the first to show that an insect might carry a protozoan parasite that was pathogenic. This observation was made in 1895.

Bruce not only determined the nature and course of "nagana," but in addition he studied the disease in a large number of domestic animals, and also observed the malady in a latent form in the wild animals of South Africa. Subsequent observers have found but little to add to Bruce's work on this subject.

In 1900 Bruce was ordered to join a commission investigating the outbreak of dysentery in the Army in South Africa, and a great part of the laboratory work performed by this commission was carried out by him.

In 1903 Colonel Bruce went, at the request of the Royal Society, to Uganda, to investigate further the nature of sleeping sickness. It was very largely, if not entirely, owing to him that the work of the Royal Society's commission was brought to a successful issue. At the time when he arrived a trypanosome had been observed by Castellani in a small number of cases of this disease; thanks to Bruce's energy and scientific insight, these observations were rapidly extended, and the most conclusive evidence obtained, that in all cases of the disease the trypanosome

was present. He showed further that a certain tsetse fly, the *Glossina palpalis*, acted as the carrier of the trypanosome, and obtained evidence showing that the distribution of the disease and of the fly were strikingly similar.

Bruce has therefore been instrumental in discovering and establishing the exact nature and cause of three widespread diseases of man and of animals, and in two of these, nagana and Malta fever, he discovered the causal organism. In the third, sleeping sickness, he was not the first to see the organism, but he was quick to grasp and work out the discovery, and he made the interesting discovery of the carrier of the pathogenic organism, and thus discovered the mode of infection and of spread of the malady, matters of the highest importance as regards all measures directed to arrest the spreading of the disease.

All this research work has been done whilst serving in the Royal Army Medical Corps, and engaged in the routine work of the Service.

Davy Medal.

The Davy Medal is awarded to Prof. W. H. Perkin, jun., F.R.S., for his masterly and fruitful researches in the domain of synthetic organic chemistry, on which he has been continuously engaged during the past twenty-five years.

Dr. Perkin's name is identified with the great advances which have been made during the past quarter of a century in our knowledge of the ring or cyclic compounds of carbon. Thus, in the year 1880, the cyclic carbon compounds known to chemists were chiefly restricted to the unsaturated groupings of six carbon atoms met with in benzene and its derivatives, whilst the number of compounds in which saturated carbon rings had been recognised was very limited, and it was indeed considered very doubtful whether compounds containing carbon rings with more or less than six atoms of carbon were capable of existence.

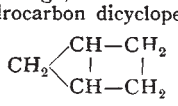
The starting point for Dr. Perkin's researches in this field of inquiry was his investigation of the behaviour of the di-halogen derivatives of various organic radicals with the sodium compounds of malonic, aceto-acetic, and benzoyl-acetic esters, which led to the synthesis of the cyclic polymethylene compounds up to those of hexamethylene, whilst heptamethylene derivatives were obtained by an adaptation of the well known reduction of ketonic bodies leading to pinacones. The reactions thus introduced by Perkin are now classical, having proved themselves of the highest importance for synthetical purposes, and having been instrumental in stimulating the further investigation of the cyclic compounds of carbon.

Dr. Perkin also extended the same methods to the synthetical formation of carbon rings of the aromatic series, obtaining by means of ingeniously designed reactions derivatives of hydrindonaphthene and tetrahydronaphthalene.

But whilst the above achievements depend mainly on happily conceived and brilliantly executed extensions of the malonic and aceto-acetic ester syntheses, Perkin has, by a remarkable development of the Frankland and Duppa reaction for the synthesis of hydroxyacids, been successful in building up the important camphoronic acid in such a manner as to place its constitution beyond doubt (1897).

Dr. Perkin has further devoted much attention to the important subject of the constitution of camphor, towards the elucidation of which he has contributed valuable experimental evidence embodied in a most important and elaborate paper, containing the results of many years' work in conjunction with numerous pupils, entitled "Sulphocamphylic Acid and Isolauronolic Acid, with Remarks on the Constitution of Camphor and Some of its Derivatives" (1898). Bearing on the same subject are later communications on camphoric acid and isocamphoronic acid.

About the year 1900, Perkin, in prosecuting his researches on the constitution of camphor compounds, succeeded in devising synthetical methods for the production of what he has termed "bridged rings," of which a simple example is furnished by the hydrocarbon dicyclopentane



The universal admiration of organic chemists has been called forth by these investigations; they reveal, indeed, a wonderful capacity for devising reactions which coerce carbon atoms to fall into the desired groupings.

Of other publications displaying not only extraordinary experimental skill but close reasoning and the power of interpreting results, mention may be made of Dr. Perkin's memorable researches on the constitution of dehydracetic acid, berberine, brasilin, and hæmatoxylin respectively.

During the present year (1904), Dr. Perkin has made perhaps the most remarkable addition to the long list of his achievements by successfully synthesising terpin, inactive terpineol, and dipentene, substances which had previously engaged the attention of some of the greatest masters of organic chemistry.

In conclusion it may be stated that Prof. Perkin is not only the author of the above and numerous other important researches which are outside the scope of this brief summary, but that he has also created a school of research in organic chemistry, which stands in the very highest rank.

Darwin Medal.

The Darwin Medal is awarded to Mr. William Bateson, F.R.S., for his researches on heredity and variation.

Mr. Bateson began his scientific career as a morphologist, and distinguished himself by researches on the structure and development of Balanoglossus, which have had a far-reaching influence on morphological science, and which established to the satisfaction of most anatomists the affinity of the Enteropneusta to the Chordate phylum. Dissatisfied, however, with the methods of morphological research as a means of advancing the study of evolution, he set himself resolutely to the task of finding a new method of attacking the species problem. Recognising the fact that variation was the basis upon which the theory of evolution rested, he turned his attention to the study of that subject, and entered upon a series of researches which culminated in the publication in 1894 of his well-known work, entitled "Materials for the Study of Variation, &c." This book broke new ground. Not only was it the first systematic work which had been published on variation, and, with the exception of Darwin's "Variation of Animals and Plants under Domestication," the only extensive work dealing with it; but it was the first serious attempt to establish the importance of the principle of discontinuity in variation in its fundamental bearing upon the problem of evolution, a principle which he constantly and successfully urged when the weight of authority was against it. In this work he collected and systematised a great number of examples of discontinuous variation, and by his broad and masterly handling of them he paved the way for those remarkable advances in the study of heredity which have taken place in the last few years, and to which he has himself so largely contributed. He was the first in this country to recognise the importance of the work of Mendel, which, published in 1864, and for a long time completely overlooked by naturalists, contained a clue to the labyrinth of facts which had resulted from the labours of his predecessors. He has brought these results prominently forward in England in his important reports to the Evolution Committee of the Royal Society, and in papers before the Royal and other societies, and also before horticulturists and breeders of animals. He has gathered about him a distinguished body of workers, and has devoted himself with great energy and with all his available resources to following out lines of work similar to those of Mendel. The result has been the supporting of Mendel's conclusions and the bringing to light of a much wider range of facts in general harmony with them. It is not too much to say that Mr. Bateson has developed a school of research to which many biologists are now looking as the source from which the next great advance in our knowledge of organic evolution will come.

Sylvester Medal.

The Sylvester Medal is awarded to Georg Cantor, professor in the University of Halle, on account of his researches in pure mathematics. His work shows originality of the highest order, and is of the most far-reaching importance. He has not only created a new field of mathematical investigation, but his ideas, in their application to analysis, and in some measure to geometry, furnish a weapon of the utmost power and precision for dealing with the foundations of mathematics, and for formulating the necessary limitations to which many results of mathematics are subject.

In 1870 he succeeded in solving a question which was then attracting much attention—the question of the uniqueness of the representation of a function by Fourier's series. The extension of the result to cases in which the convergence of the series fails, at an infinite number of suitably distributed points, led him to construct a theory of irrational numbers, which has since become classical. From the same starting point he developed, in a series of masterly memoirs, an entirely new branch of mathematics—the theory of sets of points.

Having established the fundamental distinction between those aggregates which can be counted and those which cannot, Cantor showed that the aggregates of all rational numbers and of all algebraic numbers belong to the former class, and that the arithmetic continuum belongs to the latter class, and further, that the continuum of any number of dimensions can be represented point for point by the linear continuum. Proceeding with these researches he introduced and developed his theory of "transfinite" ordinal and cardinal numbers, thus creating an arithmetic of the infinite. His later abstract theory of the order-types of aggregates, in connection with which he has given a purely ordinal theory of the arithmetic continuum, has opened up a field of research of the greatest interest and importance.

Hughes Medal.

The Hughes Medal is awarded to Sir Joseph Wilson Swan, F.R.S., for his invention of the incandescent electric lamp, and his other inventions and improvements in the practical applications of electricity. Not as directly included in the award, his inventions in dry-plate photography, which have so much increased our powers of experimental investigation.

NOTES.

THE council of the Royal Society of Edinburgh at its recent meeting decided to award Sir James Dewar, F.R.S., the Gunning Victoria Jubilee prize for 1900–4 for his researches on the liquefaction of gases extending over the last quarter of a century, and on the chemical and physical properties of substances at low temperatures.

THE *Times* reports that a telegram by wireless telegraphy has been transmitted by Mr. Marconi from the Marconi Company's station at Poldhu, Cornwall, to a station belonging to the Italian Government at Ancona, Italy. The distance between Poldhu and Ancona, about 1000 miles, is almost entirely overland, and in order to reach their destination the ether waves had to pass over nearly the whole of France and a considerable part of Italy, including some of the highest mountains of the Alps.

THE will of the late Dr. Frank McClean, F.R.S., includes the following bequests:—5000*l.* to the University of Cambridge to be expended in improving the instrumental equipment of the Newall Observatory, 5000*l.* to the University of Birmingham (in addition to his previous subscription) to be applied in the department of physical science, 2000*l.* to the Royal Society, 2000*l.* to the Royal Institution, 2000*l.* to the Royal Astronomical Society, and to the University of Cambridge for presentation to the Fitzwilliam Museum all the testator's illuminated or other manuscripts and early printed books, and all objects of mediæval or early art which the director of the museum may select as being of permanent interest to the museum.

IN a recent letter to the *Times* Prof. T. Clifford Allbutt directs attention to the paramount importance of considering the question of diet in all schemes of physical education. It is important that there should be no hasty legislation in this matter, especially in view of the important researches which are now approaching completion. Prof. Allbutt gives in his letter a brief account of the results at which Prof. Atwater, of Middletown, Connecticut, and Prof. Chittenden, of Yale University, have arrived. Prof. Atwater has measured accurately, upon healthy persons in uniform circumstances, the intake of food, and the output of waste and work, and has endeavoured to determine the modes and rates of conversion of foods into bodily and mental energy. Much of this expenditure of energy is upon an excess of food taken beyond the needs of the individual. Such excess (or not more than 4 per cent. of it) does not escape mechanically and cheaply from the body, but is absorbed, distributed, and excreted; to this process no little energy is diverted. In this useless effort energy is chiefly wasted by the nitrogenous foods. Excessive starches and sugars are burned off in the lungs almost directly, and at far less cost. Prof. Atwater teaches that the ordinary man eats too much, and in so doing wastes energy which he might have used to profit. Prof. Chittenden comes to a like conclusion by somewhat different methods. He will publish shortly tables to show how, on a closer adjustment of kinds and quantities of food to the useful work required, not only is this much work still sustained, but, by release of energy ordinarily dissipated in the demolition of food excess, the sum of work put out is prodigiously increased, in some cases even by so much as 60 per cent. or 70 per cent. It is clear enough already that one of the chief factors of physical well-being is to know what to eat, and what quantity of it results in the production of the maximum of useful energy. Until this is known with more exactitude than is common to-day, systems of physical education must be tentative and imperfectly conceived.

PROF. S. NEWCOMB has been elected corresponding member of the Berlin Academy of Sciences.

PROF. FEHR contributes to *l'Enseignement mathématique* for November 15 a list of the principal exhibits of models and books at the mathematical congress last August. Among the publishing firms exhibiting books, Germany was represented by six, Austria by two, France by four, Italy by five, Switzerland, Belgium and Denmark each by one. This is exclusive of books exhibited by societies and individuals, under which category we find the solitary British exhibit, by the Royal Irish Academy. Among the exhibitors of models our country was represented by Prof. Greenhill.

THE Belgian Government has decided upon the construction of a turbine steamer for its Channel fleet. Gradually the 19-knot steamers on this international service will be replaced by new turbine boats, with a speed of 23 knots, so that eventually even the slowest mail boats under the Belgian flag will have a speed of 21½ knots, or 24 miles an hour. The steamer which will inaugurate this departure in the progress of the service is at the present moment on the stocks at Hoboken, near Antwerp, and it will shortly be launched. Until quite recently, all steamships in the Channel and Irish Sea services were of the paddle-wheel type, a class admirably adapted for these comparatively short journeys. Drawing little water, they were able to enter any of the shallow harbours, and, at the same time, were capable of developing a speed altogether out of proportion to their draught. Since the introduction of turbines the diminution of the diameter of the propeller and of the weight of the engines has been rendered possible, so that what was until lately considered a mechanical impossibility, namely, to construct a steamer drawing only 9¾ feet and developing 12,000 indicated horse-power, may now be taken as a problem solved. The new Dover-Ostend mail boat will be a triple-screw steamer driven by Parsons' marine steam turbines. There will be three turbines—a high-pressure one in the centre, receiving the steam direct from the boilers, and a low-pressure one on each side, driven by